

The third decade was a period of unsettled weather, generally with low temperatures and rapid changes from rain to fair weather at short intervals. During this period killing frosts occurred frequently. The most severe frost occurred on the morning of the 27th in southern California and damaged citrus fruit in some sections, but to what extent is not known at present.

More than the usual number of southerly gales occurred along the coast, and the storm warnings were timely in nearly every instance.—*G. H. Willson, District Forecaster.*

HURRICANES OF 1916 AND NOTES ON HURRICANES OF 1912-1915.

By RICHARD HANSON WRIGHTMAN.

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The season of tropical storms of the year of 1916 in the West Indies was noteworthy on account of the large number of disturbances reported. In fact in only 2 previous years out of the last 40 were more storms noted—namely, in 1886 and 1887. Besides the nine more important storms noted in 1916 there were several minor disturbances which, although locally severe, were of such short duration that it was not thought advisable to chart them. The season was also remarkable for the number of disturbances of intense character within the Tropics.

Detailed descriptions of the storms that occurred during the hurricane season of 1916 are given in the issues of the MONTHLY WEATHER REVIEW for the respective months and contain all data available at the time the several numbers went to press. Data which have come to hand since the issues above mentioned are presented in this paper and tend to supplement rather than to change the information previously published. Deductions presented regarding origin, track, and intensity that differ from those previously given are based on more complete data. There follows a list of the hurricanes of the past season arranged in chronological order with a few brief remarks accompanying them. An attempt is made to give a rough idea of the intensity of the disturbances noted by the use of the terms slight intensity, moderate intensity, of severe intensity, etc., while an estimate of their extent is indicated by employing expressions such as slight, moderate, large, etc. It must be realized, however, that reports in most cases are widely scattered and that estimates such as indicated above are in a number of cases therefore merely estimates. The paths of the 1916 hurricanes are shown grouped by months on Chart X (XLIV-152) of this issue of the REVIEW.

Remarks concerning the previous history of storms are based on a study of Bulletin "X", Hurricanes of the West Indies" by Oliver L. Fassig.

Appreciation is hereby noted of a collection of reports from a number of the islands of the West Indies forwarded by Mr. Francis Watts, commissioner of agriculture, Barbados, British West Indies, and also of numerous and valuable reports from vessels at sea.

NOTES ON HURRICANES OF 1916.

July 1-10.—The disturbance originated in approximately latitude 16° N., longitude 84° W., attained moderate intensity after passing through the Yucatan Channel, and reached the Gulf coast of the United States immediately west of Mobile, Ala., as a severe storm. The lowest barometer at Mobile was 28.92 inches and the maximum wind velocity (maintained for 5 minutes),

107 miles an hour from the east. Pensacola reported a maximum velocity of 104 miles an hour from the south-east. These velocities were records for their respective stations. The velocity at Pensacola was exceeded in the storm of October 18, 1916, a report of which follows.

In a way this storm may be said to have followed an average course for the month, in that it passed to the east Gulf coast after having originated in the western Caribbean Sea.

July 11-15.—This disturbance, as far as reports are available, seems to have originated immediately east of the Bahamas in about latitude $24^{\circ} 30'$ N. It moved northwestward to the South Carolina coast, passing inland over or near Charleston, S. C. The lowest pressure reading at that station was 29.02 inches and the maximum wind velocity 64 miles an hour from the northeast. The U. S. S. *Hector* in latitude $31^{\circ} 45'$ N., longitude $78^{\circ} 53'$ W., reported a barometer reading (aneroid) of 28.37 inches which, upon subsequent comparison of the instrument, is thought to be reasonably accurate. This disturbance was moderately severe in intensity and of small area.

This is the first July storm of record that passed northwestward from the region of the Bahamas and struck the south Atlantic coast.

July 12-22.—The origin of this storm was in about latitude 15° N., longitude 61° W. The center passed northwestward to latitude 29° and thence almost due north, striking the southern New England coast with diminished energy. The lowest pressure reading, 28.94 inches (aneroid), was reported in latitude $27^{\circ} 30'$ N., longitude 73° W., by the S. S. *Ausable* shortly after 1 a. m. of the 19th, with wind force 11-12. This disturbance was of moderate to great intensity and of moderate to large area.

There is only one other storm of record in July that originated in low latitudes so far to the eastward. That storm passed westward south of the islands of the Greater Antilles, while the storm of the present year passed northwestward, north of the Antilles.

August 12-19.—This storm had its origin in approximately latitude 14° N., longitude $56^{\circ} 30'$ W. It passed westward south of the Greater Antilles and through the Yucatan Channel, later striking the Texas coast a little south of Riviera, which is situated about 45 miles southwest by south of Corpus Christi. At Kingsville, about 14 miles north of Riviera, the lowest pressure reported was 28 inches (corrected) on an aneroid barometer, while at Del Rio, at 8 a. m. (75th meridian time) on the 19th, a pressure of 28.72 inches was observed. The highest wind velocity at Corpus Christi was about 90 miles an hour. The storm was severe and moderate to large in extent.

This disturbance followed an average course for the type of August hurricanes that passes through the Yucatan Channel.

August 22.—The disturbance passed south of Tortola (Virgin Islands) and across the island of Porto Rico on a course a little north of west, the lowest pressure reported at San Juan being 29.44 inches at 7 a. m., while the maximum wind velocity was over 90 miles an hour. The origin of this storm is very uncertain and, after crossing the island of Porto Rico, there is little if any trace of it to be found. It was of moderate intensity and extremely small area.

August 28-September 1.—The exact origin of the disturbance is unknown, but was undoubtedly some distance to the east of the island of Dominica. The first trace obtainable is at Roseau, Dominica, over or immediately south of which

city it passed about 7:30 p. m., of the 28th, with a minimum pressure reading at that station of 29.12 inches. It moved thence westward and passed immediately north of the island of Jamaica, with greatly decreased intensity, to a position to the northwest of Swan Island, in which vicinity it lost intensity. It was evidently of small diameter and great intensity while passing over Dominica.

September 4-5.—This disturbance originated east of the northern Bahamas and moved northwest, passing to the coast near and south of Jacksonville, Fla. It was of slight energy and extent.

September 20-23.—The origin of this storm was near Antigua, whence it passed northwestward as far as can be ascertained from a limited number of vessel reports and recurred to the west of the Bermudas. It was of only moderate extent and slight to moderate intensity.

October 4.—This disturbance had its origin northeast of the Bahamas, moved westward and passed inland over northern Florida. It was of small extent and energy.

October 7-12.—The origin of this disturbance is somewhat difficult to determine. Conditions were very unsettled, however, in the neighborhood of the Windward Islands during the 7th and 8th. On the afternoon of the 7th there were some indications of a disturbance near and slightly to the west of Martinique. On the 8th, Roseau, Dominica, experienced a heavy sea, the breakers washing high inland and causing some damage. On the evening of the same date the wind at Basseterre, St. Kitts, veered from northeast to southeast and held in that quarter all day. The sea was heavy and the waves came up over the sea wall. Reports from Tortola, Virgin Islands, indicate that during the morning and early afternoon of the 9th the winds held southeast and were light, but about 4 or 5 p. m., they increased in force. The wind was of greatest violence about 8 or 9 p. m. (100 miles an hour, estimated). After the passage of the storm the winds veered through south and southwest to west. The following readings of the barometer were taken by Mr. W. C. Fishlock, curator at Tortola, Virgin Islands:

October 9: 7 p. m., 29.70; 7:30 p. m., 29.40; 8 p. m., 29.10; 8:30 p. m., 28.90; 8:50 p. m., 28.80; 9:30 p. m., 28.94; 9:50 p. m., 29.10; 10:30 p. m., 29.20; 11 p. m., 29.30; 11:45 p. m., 29.30-29.40 (oscillating); midnight, 29.30-29.40 (oscillating).

October 10: 12:30 a. m., 29.30-29.40; 1 a. m., 29.40; 1:10 a. m., 29.40; 3 a. m., 29.58; 7 a. m., 29.74.

Readings made by Mr. Tanggard on the Island of St. Thomas and published in Lighthour's Mail Notes, October 12, 1916, follow:

October 9: 7:30 a. m., 29.724; 1 p. m., 29.666; 2:15 p. m., 29.576; 3 p. m., 29.549; 5 p. m., 29.439; 6 p. m., 29.260; 7 p. m., 28.263; 9 p. m., 28.264; midnight, 29.261;

October 10: 6 a. m., 29.637; 8 a. m., 29.700.

The lowest reading at St. Croix, as reported in the Barbados Standard of October 12, was 28.45 inches during the night of the 9th-10th. At St. Thomas and Tortola the winds veered, while at St. Croix they backed. The disturbance evidently passed nearly over and a little to the south of St. Thomas, on a course almost due northwest and later recurved to the northeastward south of the Bermudas, evidenced by a report of hurricane winds encountered by the bark *Bellas* in latitude 27° 40' N., longitude 62° 20' W., and by a report from the *Aros Castle* (Br. SS.) in latitude 25° 18' N., longitude 63° 13' W. According to this report the *Aros Castle* experienced shifting southwesterly winds of hurricane force, with a barometer reading of 28.38 inches (aneroid) at 4 p. m. of the 11th. From earlier observations by the same vessel it is estimated that the aneroid read between 0.10 and

0.20 inch too low. The storm was of small area and of great intensity.

October 12-18.—The origin of this disturbance is somewhat doubtful, although the first definite indications place it to the south of Jamaica in approximately latitude 16° N., longitude 77° W., on the 12th. It then moved to the westward, passing south of and very close to Swan Island, where a barometric pressure of 28.94 inches was reported during the 14th, with winds of hurricane force. Several reports from vessels enable the storm to be quite closely located on the 16th and 17th and show that the disturbance, after moving a little north of west during the 15th, turned sharply to the northward on the 16th and reached the Gulf coast on the 18th, very close to and immediately west of Pensacola, Fla., where a barometer reading of 28.76 inches was reported. The maximum wind velocity, reported as 114 miles an hour, constitutes a record for the station. The storm was very intense and of moderate area.

This storm was quite remarkable for the month in that it held a westerly course in low latitudes for four days, finally reaching longitude 87° or 88° W., before turning to the northward.

November 12-15.—This disturbance originated in approximately latitude 12° N., longitude 81° W. It moved thence northwestward, recurving over the southeastern portion of the Gulf of Mexico, and advanced rapidly east-northeastward over extreme southern Florida during the 15th in the trough of a disturbance to the northward. This disturbance was evidently of marked intensity in lower latitudes, for according to press reports considerable damage was caused to property along the coast of Spanish Honduras and in Yucatan.

NOTES ON HURRICANES OF 1912-1915.

Chart X (XLIV-121), in the MONTHLY WEATHER REVIEW for September, 1916, shows the tracks of tropical storms for the period, 1912-1915. A few notes, arranged by months, follow regarding these storms.

August 10-17, 1915.—This disturbance originated slightly to the east of the island of Martinique and passed, on a course a little north of west, south of the Greater Antilles, along the northern side of the island of Jamaica. Its course then bore slightly more to the northward, and, after passing nearly over Cape San Antonio, Cuba, it advanced northwestward to the Texas coast immediately south of Galveston. The lowest pressure reading was 28.20 inches at Houston, Tex., up to this time the lowest mercurial barometer reading reported in the United States. (Record was again broken in the September, 1915, storm at New Orleans.) This storm was of hurricane intensity while in the Caribbean Sea, before passing through the Yucatan Channel, as indicated by the destruction of the wireless tower and other equipment at Cape San Antonio. The storm was of great magnitude.

The track of this disturbance was not abnormal for August storms that pass through the Yucatan Channel. In this connection, it is interesting to note that all previous August storms that have passed through the Yucatan Channel have advanced without recurve to the Texas or Mexican coasts, no storm of this character ever having struck the Gulf coast east of Galveston.

August 29-September 9, 1915.—As nearly as can be ascertained, this disturbance had its origin in a proximately latitude 27° N. and longitude 27° W. It moved first on a course slightly north of west, passing to a position northwest of the Bermudas, whence it passed southward to the west of the Islands, then southeastward, then

westward and later northward and northeastward. From the evening of the 2d to the evening of the 4th the pressure at Hamilton ranged between 29.17 and 29.32 inches.

The track of this storm was most unusual, its recurve being blocked and the storm forced southward by the high pressure to the northward. The storm was moderately severe and of moderate area.

September 1-4, 1915.—This disturbance originated in approximately latitude 16° N., longitude 80° W., and after passing north-northwestward over western Cuba, crossed the Gulf coast immediately west of Apalachicola. The lowest pressure recorded at that station was 29.32 inches. A pressure of 29.08 inches, however, was reported by the United States Coast Guard cutter *Miami* off the west coast of extreme southern Florida on the morning of the 3d. The intensity of this storm was moderately severe and its diameter extremely small.

September 22-30, 1915.—This storm had its origin to the west of the Windward Islands in approximately latitude $14^{\circ} 30'$ N., and longitude 63° W. It moved westward, passing south of Jamaica and thence northwest through the Yucatan Channel, crossing the Gulf coast slightly west of New Orleans. The lowest pressure recorded at that station was 28.11 inches, which is probably the lowest reading of a mercurial barometer ever observed

in the United States. The report of lowest pressure observed at sea was given by the S. S. *Almirante*, in approximately latitude $15^{\circ} 50'$ N., and longitude $77^{\circ} 30'$ W. The report contained information as follows: "Barometer pumping between 27.50 and 27.60 inches." The barometer was an aneroid with a correction of plus 0.01 inch. This is the lowest authentic reading reported in the West Indies or Caribbean Sea so far as known.

The hurricane was the most intense in history so far as our records show and was of large area. The track was not unusual for a storm of this month that passes from the Caribbean Sea through the Yucatan Channel.

October 11-17, 1912.—This disturbance originated a short distance west of Jamaica in approximately latitude 18° N., longitude 80° W., and, after passing west-northwestward through the Yucatan Channel, struck the Texas coast at a point about equally distant from Corpus Christi and Brownsville. The disturbance was of only moderate intensity and of small to moderate area.

The course of this disturbance was most unusual when compared to other October storms that passed through the Yucatan Channel. Only one previous storm of record followed a track at all similar to the 1912 storm, namely, that of 1887. The storms of 1886, 1887, and 1912 are the only tropical storms in the month of October that have struck the Gulf coast west of Mobile.